Higgs Boson

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channels of search , results from all experiments

Introduction

Higgs Boson is an elementary particle in the standard model of particle Physics.

It is the quantum of excitation of the Higgs field.

A theory came in 1964 by Peter Higgs and two more groups simultaneously that is essential for standard model for generation of masses for the w+- bosons & Z bosons through electro weak symmetry breaking.

Higgs field gives mass to quarks,

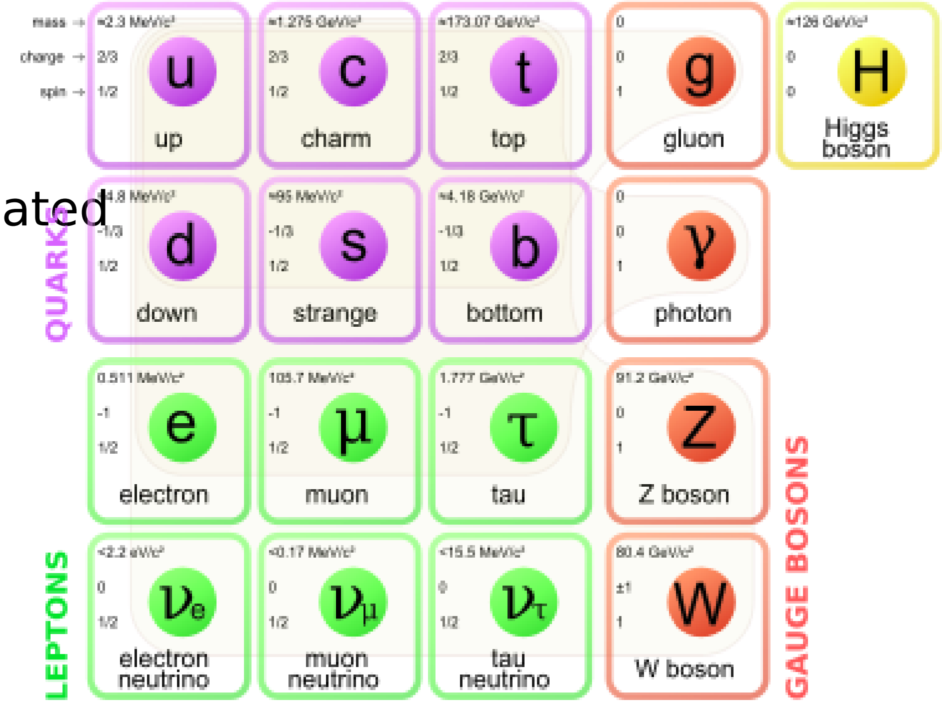
Leptons, W and Z boson.

If there is a field it should be associated

with some particle.

So search for Higgs boson started

from LEP,Tevatron to LHC.

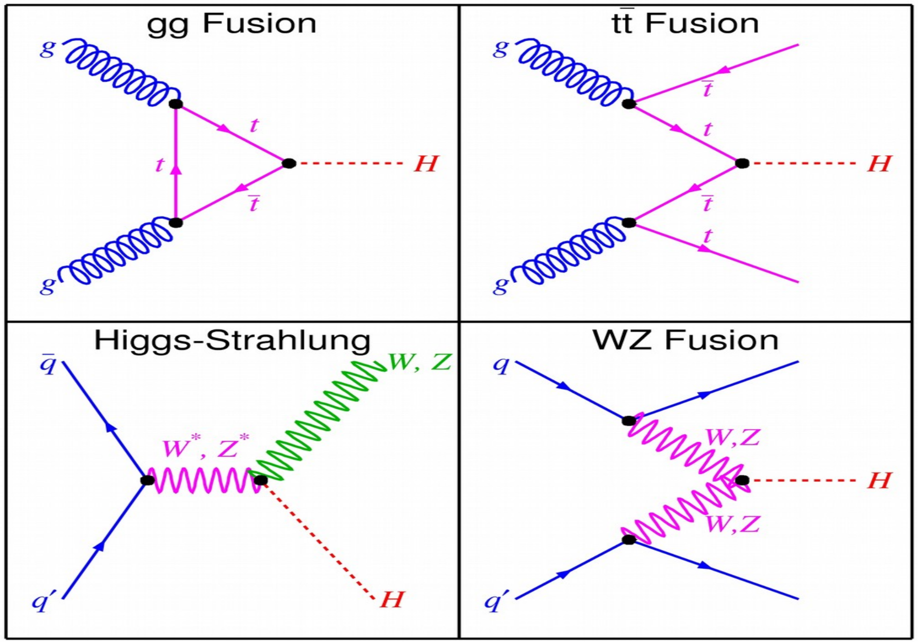


How Higgs boson may be formed

Different processes

in which Higgs boson may be forme

in the experiment



Higgs Decay modes and
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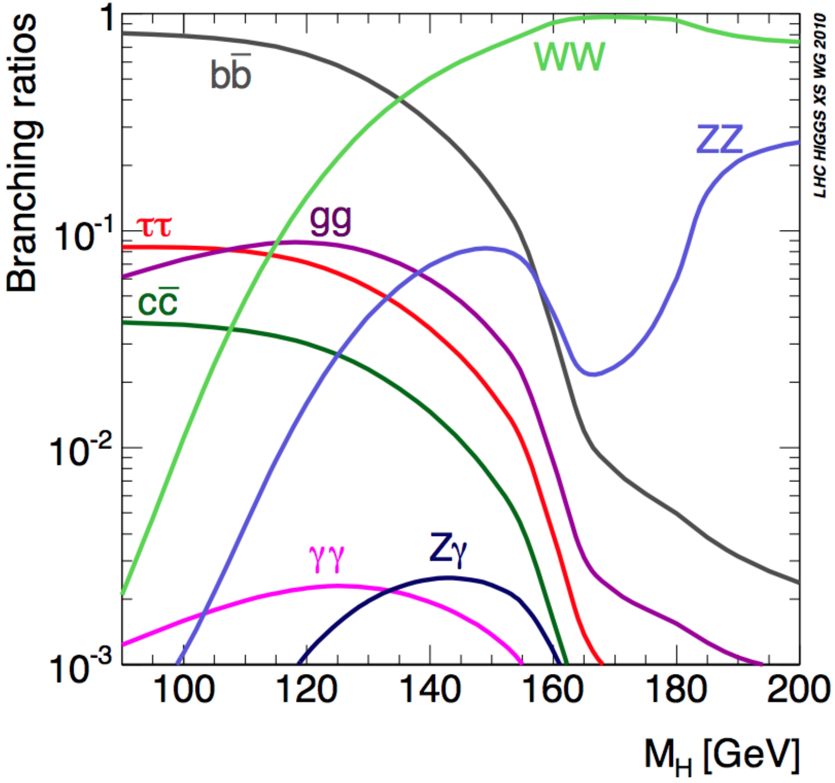


Higgs has many different decay modes

I will discuss on ZZ and YY channel

Search at LEP(Large Electron Positron Collider)

In 1990s LEP start working

Collide electrons with positron at energy nearly about 209 Gev

Looked for

(1)Decay of Z boson into Higgs and a pair of fermions.

(2)e+ e- together produce Z boson which in turn radiates Higgs boson

Called Higgs Strahlung.

But no decay events found . It was concluded that if it exists it should be heavier than Z boson

Results from LEP

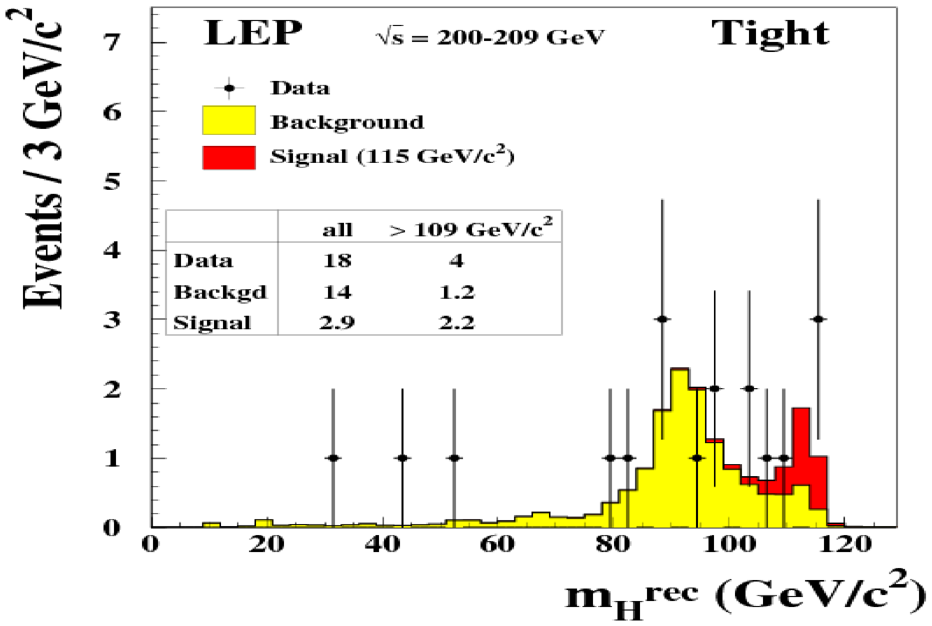
Few events that resembles like

Higgs boson with a mass of

115 GeV/c^2.

This data was insufficient and Final

Shut down in November 2000.



Search at Tevatron

A proton and antiproton collider at energy around 1.2 Tev started in March 2001.

But if the Higgs were too heavy (>180 Gev) then collision would not have enough energy to produce Higgs boson.

If Higgs were too light (<140 Gev) then there would be more background event.

Results from Tevatron

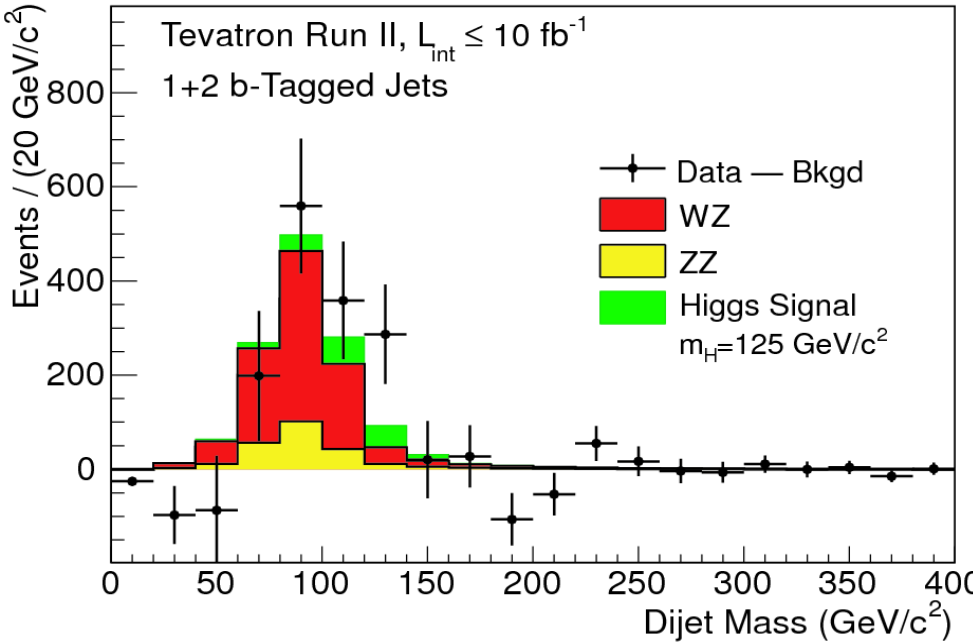
Found an excess of event that coul

be from Higgs boson in between

115-140 GeV/c^2 with large backgrou

Finally in 2011 Tevatron was shut

down



Search at LHC

First started on 10 th september 2008

Collide two proton at 7 Tev energy then energy was upgraded further

Looked for Higgs boson in the mass range of 115 Gev/c^2 to 150 Gev/c^2

Both ATLAS and CMS collaboration discovered Higgs in 4 July 2012

The results I will be showing is from both 7 TeV and 8 TeV pp collision data

Search at CMS

CMS experiment is one of the sub detector at LHC

The main components are

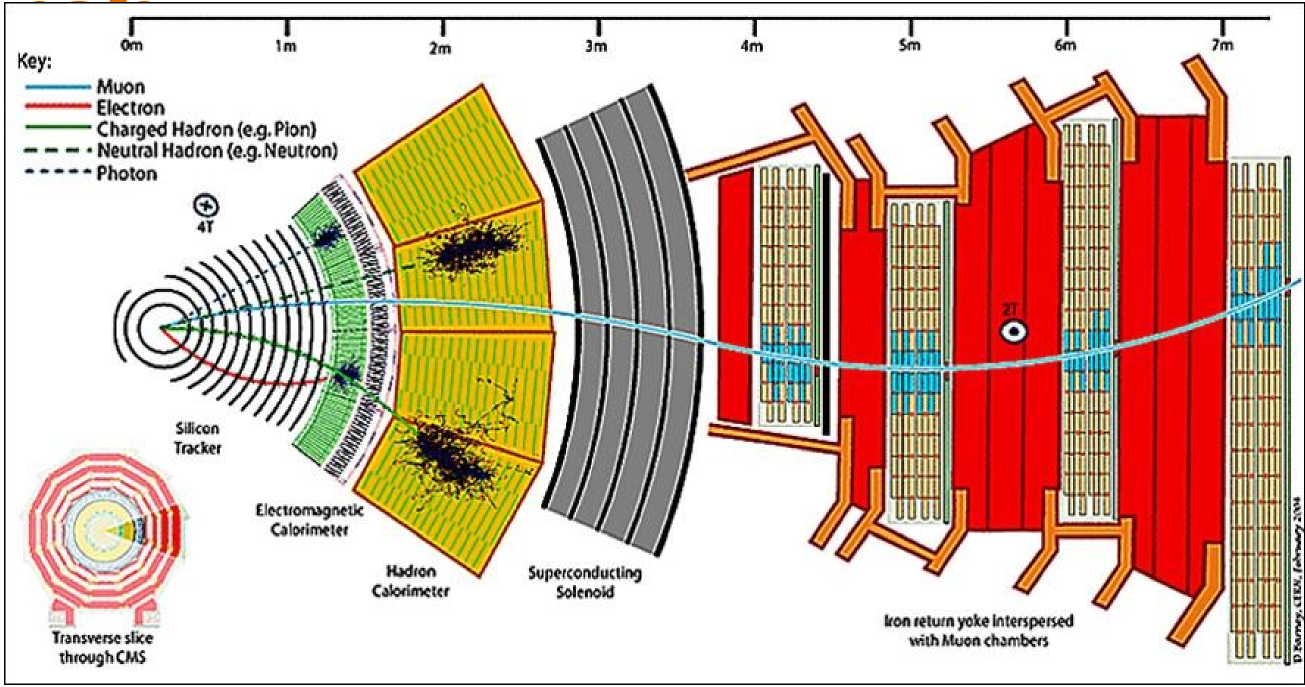
1. Tracker → Measures momentum of Electrons and other charged particles
2. Electromagnetic calorimeter → Photons and electrons
3. Hadronic Calorimeter → Hadron’s energy
4. Muon Chamber

CMS detector designed for Higgs search

Several layers of

detectors inside

the CMS detector

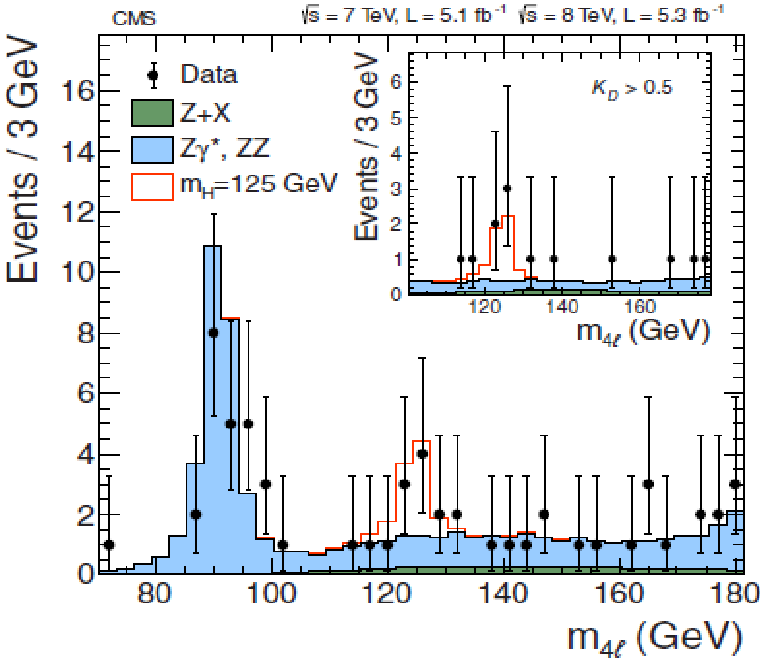


Higgs -> ZZ->4l

There is a clear peak around

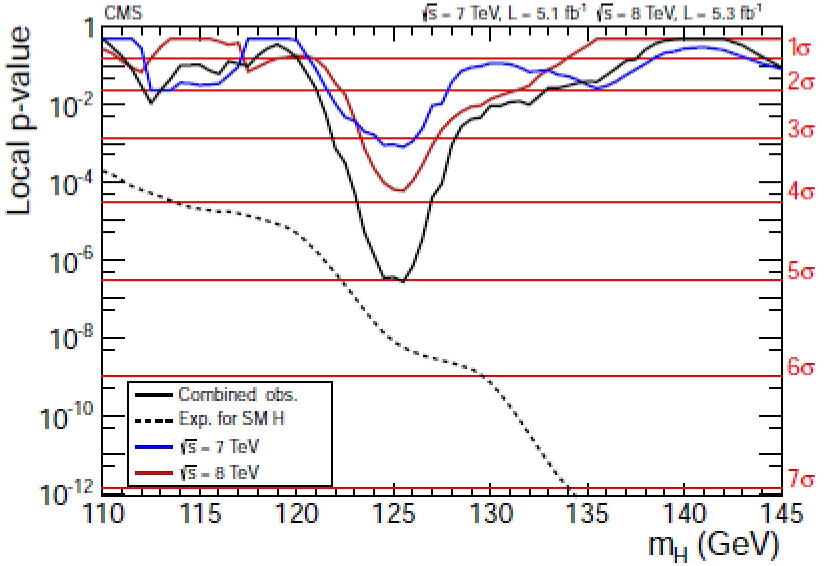
125 Gev/c^2

The figure also shows an excess of events around 125 Gev



Decay mode/combination	Expected (σ)	Observed (σ)
$\gamma\gamma$	2.8	4.1
ZZ	3.8	3.2
$\tau\tau$ + bb	2.4	0.5
$\gamma\gamma$ + ZZ	4.7	5.0
$\gamma\gamma$ + ZZ + WW	5.2	5.1
$\gamma\gamma$ + ZZ + WW + $\tau\tau$ + bb	5.8	5.0

mbined



The observed local p - value for 7 Tev,8 Tev data and their combination as a function of Higgs boson mass.

The dashed line shows the expected local p-value for Higgs boson with mass m_H

Search in YY channel from CMS

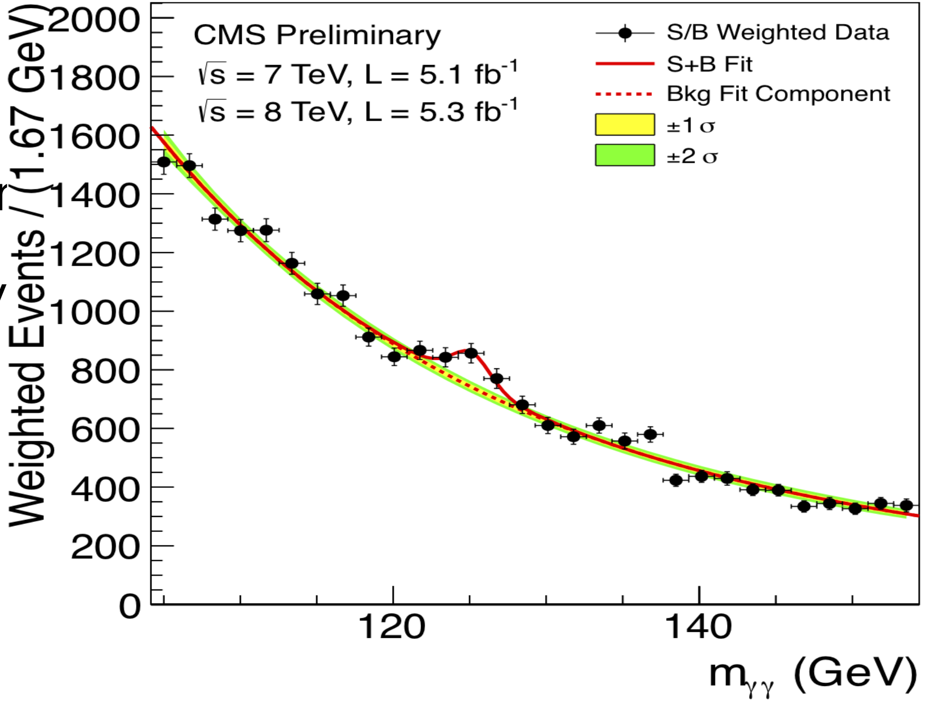
Although the BR for YY production is

Very less but this is very useful

For us because energy and momentum

Of the photons can be measured very

precisely



ATLAS

ATLAS is another detector like CMS designed to dedicated analyses like Higgs search, standard model measurements.

ATLAS detector is made for similar physics goals and it helps to cross check the results from two different experiments.

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Conclusion

Final result

Mass=125.09 +/- 0.11 GeV/C^2

Mean lifetime =1.56*10^{-22}s

spin=0, parity=+1

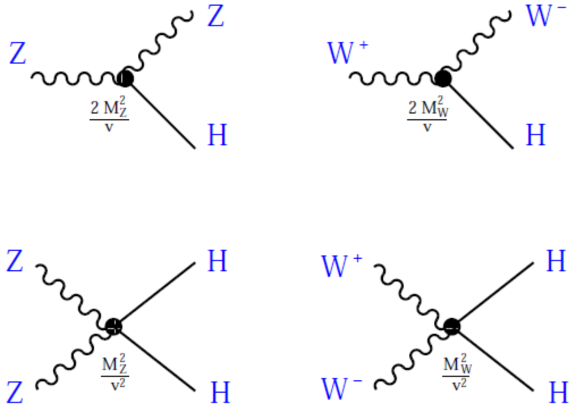
Electric charge=0

Color charge=0

THANK

YOU

Backup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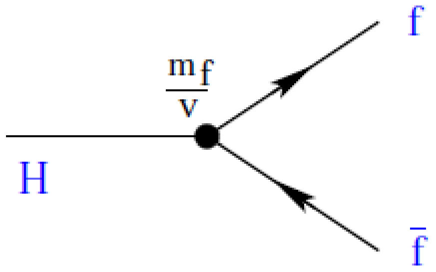
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H->ZZ->4l abstract

A search for the Higgs boson in the H $\rightarrow$ ZZ four-lepton decay channel, with each Z boson decaying to an electron, a muon, or a tau pair, is reported. The search covers Higgs boson mass hypotheses in the range $110 < m_H < 600$ GeV. The analysis uses pp collision data recorded by the CMS detector at the LHC, corresponding to integrated luminosities of 5.05 fb^{-1} at $\sqrt{s} = 7$ TeV and 5.26 fb^{-1} at $\sqrt{s} = 8$ TeV. The four-lepton invariant-mass distributions for $m_{4\ell}$ and $m_{2\ell 2\tau}$ are found to be consistent with the standard model expectations for background ZZ production for invariant masses above 180 GeV. Upper limits at 95% confidence level exclude the standard model Higgs boson in the range 131–162 and 172–525 GeV, while the expected exclusion range is 121–570 GeV. An excess of events is observed in the low $m_{4\ell}$ mass range, making the observed limits weaker than expected in the absence of a signal. These events cluster around a mass $m_{4\ell} \simeq 125.5$ GeV, giving rise to a local excess with respect to the background expectation, with a significance of 3.2σ. This result constitutes evidence for a new massive state.

Upper limit explanation

The individual results for the channels analysed for the five decay modes, summarised in Table 1, are combined using the methods outlined in Section 4. The combination assumes the relative branching fractions predicted by the SM and takes into account the experimental statistical and systematic uncertainties as well as the theoretical uncertainties, which are dominated by the imperfect knowledge of the QCD scale and parton distribution functions. The CL_s is shown in Fig. 13 as a function of the Higgs boson mass hypothesis. The observed values are shown by the solid points. The dashed line indicates the median of the expected results for the background-only hypothesis, with the green (dark) and yellow (light) bands indicating the ranges in which the CL_s values are expected to lie in 68% and 95% of the experiments under the background-only hypothesis. The probabilities for an observation, in the absence of a signal, to lie above or below the 68% (95%) band are 16% (2.5%) each. The thick horizontal lines indicate CL_s values of 0.05, 0.01, and 0.001. The mass regions where the observed CL_s values are below these lines are excluded with the corresponding $(1 - CL_s)$ confidence levels. Our previously published results exclude the SM Higgs boson from 127 to 600 GeV [21]. In the search described here, the SM Higgs boson is excluded at 95% CL in the range $110 < m_H < 121.5$ GeV. In the range $121.5 < m_H < 128$ GeV a significant excess is seen and the SM Higgs boson cannot be excluded at 95% CL.